

08/30/00
JC920 U.S. PTO

08-31-00

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Case Docket No. FUJ 17.433
Filed by Express Mail
(Receipt No. EL522338350US)
on August 30, 2000
pursuant to 37 CFR 1.10
by Lydia Gonzalez

10:036 U.S. PTO
09/05/98
08/30/00

S I R:

Transmitted herewith for filing is: ☒ a new application
☐ a c-i-p application of S.N. _____ filed _____

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For LAYER 2 LINK HANDLER AND PATH CONNECTION METHOD THEREFORE

Enclosed are:

- ☒ 27 sheets of drawings. (Figs. 1-8, 9A, 9B, 10A, 10B, 11A-11C, 12, 13, 14A, 14B, 15A, 15B, 16A, 16B, 17A, 17B, 18-22, 23A-23C, 24-27)
- ☒ Specification, including claims and abstract (24 pages)
- ☒ Declaration
- ☒ An assignment of the Invention to FUJITSU LIMITED
- ☒ A certified copy of Japanese Application No(s). 11-249627
- ☒ An associate power of attorney
- ☐ A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27
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LAYER 2 LINK HANDLER and PATH CONNECTION METHOD THEREFORE

Field of Invention

As one means for speeding up TCP/IP communication, systems are being adopted that employ an ATM (asynchronous transfer mode) network or other wide-area network as the low-level physical layer of the IP communication. This invention concerns a handler and layer 2 link path connection method that handle layer 2 link paths between such layer 3 IP communication and the ATM or other wide-area network of the low-level physical layer.

There are two types of path connections in an ATM network: an SVC (switched virtual connection) path, in which the user connects the path by specifying the other party every time communication is begun, and a PVC (permanent virtual connection) path, in which the path to the other party of the connection is set in advance.

An SVC (switched virtual connection) path is like a path connected in the present telephone network, according to the telephone number of the other party that is specified by the user. The ATM path is set according to the user side's specification of the other party's address on the ATM network, and it is set between the user side and the ATM exchange by exchanging, by a protocol known as I.2931, control signals (signaling) for ATM path setting, including a path connection request.

A PVC (permanent virtual connection) path is a path that is continuously set by a fixed path with the other party. Signaling is not needed to set a path between the user side and the ATM exchange; the path is set in advance by the operator on the ATM network side.

Figure 26 shows an example of connections using PVC (permanent virtual connection) paths between the user-side device and the device of network service provider (NSP) side. In this mode of connection, the connection destination of each user-side device is fixed, and one cannot select and connect to an arbitrary network service provider (NSP).

Figure 27 shows the frame composition if IP (Internet protocol) frame data is transmitted along ATM paths such as the aforesaid PVC (permanent virtual connection) paths. As shown in this diagram, a layer 3 IP frame is encapsulated in a layer 2 PPP (point-to-point protocol) and is broken up by AAL5 (ATM adaptation layer type 5) into ATM cells of the physical layer.

If data communication service, etc. by IP frames is to be supplied by connection by such a PVC (permanent virtual connection) path between the user side and the network service provider (NSP) side, the following will be required of the equipment on the ATM network side.

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If each user wishes to make connections to multiple network service providers (NSPs), then there will be cases in which the user contracts simultaneously with multiple network service providers (NSPs) and chooses which network service provider (NSP) to connect to depending on the content of the communication or whether it is for private or commercial use.

Also, depending on the country, it is required that carriers offer users fair access open points to network service providers (NSPs), such as prohibiting network service provision by carriers or imposing the obligation that each carrier fairly provide access to the network service provider (NSP) the user wants.

For the above reasons, it is necessary that the ATM-side equipment be able to fairly access any network service provider (NSP) as demanded by the user, and it is required that a switching connection be made to any network service provider (NSP) the user wants, even if the user and the network service provider (NSP) are connected by a PVC (permanent virtual connection) path.

When a PVC (permanent virtual connection) path is individually set to a network service provider (NSP) from each user, the number of PVC (permanent virtual connection) paths connected to a network service provider (NSP) becomes enormous, so the equipment on the side of each network service provider (NSP) must be able to handle an enormous number of PVC (permanent virtual connection) paths.

Traffic line collection is difficult to do because, despite the concentration of traffic in the equipment on the side of a network service provider (NSP), a single PVC (permanent virtual connection) path has a 1-to-1 correspondence with the PPP link, and the channel identifiers on the ATM layer are different for each PVC (permanent virtual connection) path.

SUMMARY OF THE INVENTION

It is an object of the present invention to make it possible for a user-side device connected by a permanent virtual connection path to select and connect one among multiple specified connection destinations. The present invention provides a layer 2 link handler and a path connection method therefor such that it is possible to do traffic line collection by setting multiple layer 2 links on a single physical layer circuit, make network operation efficient, and execute high-speed switching in which multiple layer 2 links are logically separated.

Also, due to the present invention, high-speed switching by hardware becomes possible by doing switching by the assigned labels of layer 2 packets, without referencing the IP address within the layer 3 IP header, etc.

The path connection means has a distribution means that, by switching on the layer 2 packet level, distributes and transfers packets that arrive from the permanent virtual connection path connected with the user-side device to one path of the connection request destination.

The path connection means may have a labeling means which, based on layer 2 link information emitted from the user-side device at the time of a layer 2 link connection request, assigns a label of each layer 2 link of said connection request to a layer 2 packet from the user-side device, and said path connection means has a means that transfers, by label multiplex layer 2 links, the layer 2 packet labeled by the labeling means to the path to said specified connection destination.

The labeling means may have a selection means that, when a label is newly assigned to a layer 2 link, selects an arbitrary available label number and emits a labeled layer 2 packet, and said path connection means handles the link of the labeled layer 2 packet that is assigned the same label number and is sent back from the side of the device that received said labeled layer 2 packet, as a link of the pair of the layer 2 link newly assigned a label.

The labeling means, when it newly assigns a label to a layer 2 link, determines the label number by doing a negotiation mutually with the other device side.

The path connection means recognizes the labels of layer 2 packets that arrive from the permanent virtual connection path with the user-side device and to which are assigned labels according to the quality-of-service class of each layer 2 link, and transfers layer 2 packets to the path to the specified connection destination that corresponds to the given label.

The path connection means may recognize the labels of layer 2 packets that arrive from the permanent virtual connection path with the user-side device and to which are assigned labels according to the connection destination of each layer 2 link, and transfer layer 2 packets to the path to the specified connection destination that corresponds to the given label.

The path connection means may recognize the labels of layer 2 packets assigned according to the distribution type of service in the IP packet within layer 2 link packets that arrive from the permanent virtual connection path with the user-side device, and transfer layer 2 packets to the path to the specified connection destination that corresponds to the given label.

The path connection means may have an extracting means that extracts the request connection destination name from layer 2 link information emitted from the user-side device at the time of a layer 2 link connection request and a conversion table that converts from said connection destination name to a connection address, and said path connection means has a means that uses the connection address obtained from said conversion table to cause a path to be connected between the user-side device and the specified connection destination.

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The above configuration can be combined appropriately, and is also applied to a layer 2 link handler provided in a user-side network terminating device or a network-side subscriber line concentrator device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 2 is an explanatory diagram of a mode of implementation of the present invention for PVC (permanent virtual connection) path setting by ATM switching;

Fig. 4 is an explanatory diagram of a mode of implementation of the invention for SVC (switched virtual connection) path setting by ATM switching;

Fig. 5 is an explanatory diagram of a mode of implementation of the invention for SVC (switched virtual connection) path setting by layer 2 switching;

Fig. 6 is a diagram that shows the first mode of implementation of the invention for layer 2 switching by labeling;

Fig. 7 is a diagram that shows the second mode of implementation of the invention for layer 2 switching by labeling;

Fig. 23 (a, b, c) show an explanatory diagram of an example of the composition of the layer 2 handler of the invention;

Fig. 25 is a diagram that shows an example of the format of a labeled layer 2 packet of the invention;

Fig. 27 is a diagram that shows the frame composition if IP frames are transmitted along ATM paths.

Figure 1 is an explanatory diagram of the layer 2 handler of the present invention. Layer 2 handler 1-11 is provided within network-side device (for example, subscriber line concentrator device) 1-10, and by means of the layer 2 handler 1-11, the user-side device connected by a PVC (permanent virtual connection) path is selectively connected to one path of multiple specified connection destinations, such as network service providers (NSPs).

Layer 2 handler 1-11 identifies one path of specified connection destinations based on information for establishing a layer 2 link emitted by the user-side device at the time of initiation of the layer 2 link (PPP, etc.) connection of the user-side device, and a layer 2 packet (PPP packet, etc.) sent from the user-side device to the identified path of the specified connection destination is emitted via ATM switch 1-12, etc.

By using as an example a layer 2 link on a PVC (permanent virtual connection) path of the ATM network will be explained. However the layer 1 physical layer is not limited to an ATM network; it may also be a network such as SONET, Ethernet, or frame relay. The same is true also for all the following modes of implementation. In the following, specific implementations of a layer 2 handler to be selectively connected to a specified connection destination will be described.

Figure 2 is an explanatory diagram of a mode of implementation of the present invention for PVC (permanent virtual connection) path setting by ATM switching. If between each user-side device #1 to #5 and layer 2 handler 2-11 the connection is made by a PVC (permanent virtual connection) path, and between layer 2 handler 2-11 and the device on the network service provider (NSP-A, NSP-B) side the connection is made by a PVC (permanent virtual connection) path, then layer 2 handler 2-11 connects, by switching at the ATM level (in ATM cell units) the PVC (permanent virtual connection) path from each user-side device #1 to #5 to one specified connection destination path of a device, etc. on the network service provider (NSP-A, NSP-B) side.

Figure 3 is an explanatory diagram of a mode of implementation of the invention for PVC (permanent virtual connection) path setting by layer 2 switching. As in the above implementation, if between layer 2 handler 3-11 and the device on the network service provider (NSP-A, NSP-B) side the connection is made by a PVC (permanent virtual connection) path, then layer 2 handler 3-11 connects, by switching at the layer 2 packet level (in packet units such as PPP packets) the PVC (permanent virtual connection) path from each user-side device #1 to #5 to one specified connection destination path of a device, etc. on the network service provider (NSP-A, NSP-B) side.

Figure 4 is an explanatory diagram of a mode of implementation of the invention for SVC (switched virtual connection) path setting by ATM switching. If between each user-side device #1 to #5 and layer 2 handler 4-11 the connection is made by a PVC (permanent virtual connection) path, and between layer 2 handler 4-11 and the device on the network service provider (NSP-A, NSP-B) side the connection is made by an SVC (switched virtual connection) path, then layer 2 handler 4-11 specifies one connection destination, such as a network service provider (NSP), from information, etc. for establishing a layer 2 link emitted by the user-side device at the time of initiation of the layer 2 link connection of the user-side device.

Layer 2 handler 4-11 newly establishes an SVC (switched virtual connection) path to said specified connection destination by a signaling protocol. Layer 2 handler 4-11 sets connects, by switching at the ATM level (in ATM cell units) the PVC (permanent virtual connection) path with the user-side device to an SVC (switched virtual connection) path of one specified connection destination, such as a network service provider (NSP).

Figure 5 is an explanatory diagram of a mode of implementation of the invention for SVC (switched virtual connection) path setting by layer 2 switching. As in the implementation shown in Figure 4, layer 2 handler 5-11 specifies one connection destination, such as a network service provider (NSP), from information, etc. for establishing a layer 2 link emitted by the user-side device at the time of the beginning of the layer 2 link connection of the user-side device.

Layer 2 handler 5-11 newly establishes an SVC (switched virtual connection) path to said specified connection destination by a signaling protocol. Layer 2 handler 5-11 makes a layer 2 connection between the user-side device and one specified connection destination by switching, at the layer 2 packet level, the layer 2 packet (PPP packet, etc.) that arrives from the PVC (permanent virtual connection) path with the user-side device to an SVC (switched virtual connection) path of one specified connection destination, such as a network service provider (NSP).

Figure 6 is a diagram showing the first mode of implementation of the invention for layer 2 switching by labeling. If between each user-side device #1 to #5 and layer 2 handler 6-11 the connection is made by a PVC (permanent virtual connection) path, and between layer 2 handler 6-11 and the device on the network service provider (NSP-A, NSP-B) side the connection is made by a PVC (permanent virtual connection) path or SVC (switched virtual connection) path, then layer 2 handler 6-11 specifies one connection destination from information, etc. for establishing a layer 2 link emitted by the user-side device at the time of the beginning of the layer 2 link connection of the user-side device.

Within layer 2 handler 6-11, a label to identify each individual layer 2 link is assigned to each layer 2 packet (PPP packet, etc.) that arrives from a PVC (permanent virtual connection) path with the user-side device, the labeled layer 2 packets are switched at the layer 2 packet level, and a layer 2 connection is made between the user-side device and the specified connection destination by multiplexing multiple layer 2 links into a single path of said specified connection destination.

Normally, a PPP packet, etc., which is a layer 2 packet, can set only one link on one physical layer circuit, but by making a conversion to labeled layer 2 packets it becomes possible to set multiple layer 2 links on one physical layer circuit.

And by multiplexing and setting multiple layer 2 links on one physical layer circuit, such as an ATM path, the traffic multiplexing effect comes into play, one physical layer circuit such as an ATM network circuit (VC) is effectively used, and the number of them can be reduced.

Figure 7 is a diagram showing the second mode of implementation of the invention for layer 2 switching by labeling. Between each user-side device #1 to #5 and layer 2 handler 7-11 the connection is made by a PVC (permanent virtual connection)

Each user-side device #1 to #5 emits to a single PVC (permanent virtual connection) path a labeled layer 2 packet assigned a label to distinguish individual layer 2 links. That is, layer 2 links that are assigned different labels are multiplexed and set on a single PVC (permanent virtual connection) path between the user-side device and layer 2 handler 7-11.

Layer 2 handler 7-11 performs a label conversion on the labeled layer 2 packets (PPP packets, etc.) that arrive from the PVC (permanent virtual connection) path with the user-side device, performs switching on the layer 2 packet level to one of the paths of the specified connection destinations to which the labeled layer 2 packet corresponds to said label, and, as in the above mode of implementation shown in Figure 6, connects the user-side device and said connection destination by a multiplexed layer 2 link path between layer 2 handler 7-11 and the specified connection destination.

Figure 8 is an explanatory diagram of the invention's process of establishing layer 2 links. Layer 2 handler (L2H) can be constituted so that for complex processing - including the negotiation until one connection destination is specified from the information, etc. emitted by the user-side device (User) for establishing a layer 2 link when the layer 2 link connection of the user-side device (User) is initiated -- the processing is done by software, and for switching processing of the PVC (permanent virtual connection) path or SVC (switched virtual connection) path once the one connection destination has been specified, high-speed switching is done by hardware.

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Layer 2 handler 9-11 indicates the specified connection destination to ATM switch 9-12, and ATM switch 9-12, as shown in (b) of the diagram, performs switching on the ATM level to the indicated specified connection destination and connects the PVC (permanent virtual connection) path from the user-side device to the specified connection destination.

The composition is such that the connection on the ATM level is made not within layer 2 handler 9-11; until selection of the specified connection destination, processing is done by layer 2 handler 9-11 by giving instructions to ATM switch 9-12, and switching to make the connection to said specified connection destination is done using ATM switch 9-12.

Figure 10 is an explanatory diagram of the first mode of implementation of this invention having a conversion table to ATM addresses. As shown in (a) of the diagram, between the user-side device and layer 2 handler 10-11, and between layer 2 handler 10-11 and the device on the network service provider (NSP) side, the connection is made by a PVC (permanent virtual connection) path via ATM switch 10-12.

As shown in (b) of the diagram, layer 2 handler 10-11 has a conversion table from specified connection destination names, such as network service provider (NSP) names, to the ATM address of the PVC (permanent virtual connection) path that corresponds to a given specified connection destination.

From the name of the specified connection destination, such as the name of a network service provider (NSP), included in the information for establishing a layer 2 link that is emitted by the user-side device at the time of initiation of a layer 2 link connection with the user-side device, layer 2 handler 10-11 uses said conversion table to obtain the ATM address that corresponds to said connection destination, and makes the ATM connection based on said ATM address.

By such a composition, a connection can be selectively made to a network service provider or other specified connection destination connected by a PVC (permanent virtual connection) path, even if the user-side device is not aware of the ATM address of the specified connection destination.

Figure 11 is an explanatory diagram of the second mode of implementation of this invention having a conversion table to ATM addresses. As shown in (a) of the diagram, between the user-side device and layer 2 handler 11-11 a connection is made by a PVC (permanent virtual connection) path via ATM switch 11-12, and between layer 2 handler 11-11 and the device on the network service provider (NSP) side, a connection is made by an SVC (switched virtual connection) path via ATM switch 11-12.

If the relevant specified connection destination is connected by a PVC (permanent virtual connection) path, layer 2 handler 13-11 emits a layer 2 packet to said PVC (permanent virtual connection) path, but if the relevant specified connection destination is not connected by a PVC (permanent virtual connection) path, it newly sets a path to said specified connection destination using an SVC (switched virtual connection) path.

Figure 14 is an explanatory diagram of a mode of implementation of the present invention that assigns arbitrary labels. In the labeling in the aforesaid modes of implementation shown in Figures 6 and 7, etc., the device on the side that newly assigns labels to layer 2 links and emits labeled packets selects arbitrary available label numbers and assigns to layer 2 packets, and the device that receives said labeled layer 2 packets assigns to the return-direction link corresponding to a received link a label of the same number as the number of said assigned label.

As shown in (b) of the diagram, the network service provider that receives layer 2 packet bearing label #2 (NSP-A) assigns the same label #2 as the received layer 2 packet to the link to layer 2 handler 14-11 corresponding to the link on which the layer

2 packet bearing label #2 was received. Such a labeling system makes it possible to easily label layer 2 links in both directions.

Figure 15 is an explanatory diagram of a mode of implementation of the invention that does labeling to prevent collisions. If the same label number is assigned to a layer 2 link so as to form the pair described above, then a different marking is made on each label, as between the side that first selects an arbitrary available label number and emits a labeled layer 2 packet, and the side that assigns the same label number to the link of the pair on the side that receives said labeled layer 2 packet and emits it.

As shown in (a) of Figure 15, if layer 2 handler 15-11 sets a new link 'a' when a bidirectional layer 2 link to which label #1-0 and label #1-1 have been assigned is set between it and a network service provider (NSP-A), then layer 2 handler 15-11 selects and allocates an arbitrary label #2-0 that is not currently being used and transmits a layer 2 packet to which said label #2-0 is assigned.

At this time, the operation of simultaneously setting link 'b' also from the network service provider (NSP-A) device side is begun, and if at that time by chance the same label #2-0 is selected and assigned, then layer 2 handler 15-11 will recognize it as the pair of link 'a', even though the two are separate links.

Thus, for the label number selected and allocated by the originating device, a labeled layer 2 packet with a label number assigned, for example, the marking "0 is transmitted, and the other device that receives the layer 2 packet to which this marking is assigned puts, for example, the marking "1 on the label number of the layer 2 packet to be emitted to the link of the pair.

As shown in (b) of the diagram, because it can be assumed that label number #2-1 is assigned to the layer 2 packet that is transmitted to the link of the pair of link 'a' to which label number #2-0 was assigned, layer 2 handler 15-11 is able to distinguish by label number #2-0 assigned as link 'b' that the device on the network service provider (NSP-A) side newly tries to set, and while being a simple labeling system, label number collisions can be avoided even if both devices do label management independently.

Figure 16 is an explanatory diagram of a mode of implementation of the invention that does labeling by negotiation. As shown in (a) of the diagram, if layer 2 handler 6-11 sets a new link when a layer 2 link to which label #1 is assigned is set between it and a network service provider (NSP-A), then a negotiation takes place mutually with the network service provider (NSP-A) concerning label numbers, and, as shown in (b) of the diagram, an arbitrary label #2 that is not currently being used is selected and decided upon, and a bidirectional link of label #2 is set. Negotiation makes it possible to assign labels without any collisions.

Layer 2 handler 17-11 and the network service provider (NSP-A) can do labeling without collisions by assigning to the layer 2 links labels prescribed by operation of the network management operation device.

Figure 19 is an explanatory diagram of a mode of implementation of the invention that does labeling according to connection destination. The user-side device or user-side network terminating device (ONU) assigns labels classified by the connection destination and emits layer 2 packets, and based on the labels, layer 2 handler 19-11 distributes them to PVC (permanent virtual connection) paths classified by each connection destination. At this time, label conversion is also done, and layer 2 packets of the same connection destination are made multiplex and emitted on a single PVC (permanent virtual connection) path.

Here, for distribution type of service (ToS), information on the type of distribution route requested from the user-side device determines, in accordance with it, the selection of the distribution route, such as whether to use a route whose delay is as small as possible, whether to use a route whose throughput is as large as possible, or whether to use a route whose reliability is as high as possible.

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Figure 21 is an explanatory diagram of a user-side network terminating device (ONU) of this invention that does labeling according to distribution type of service. Based on the value of the distribution type of service (ToS) field in the IP packet within a layer 2 packet, user-side network terminating device (ONU) assigns "ToS" classified labels to layer 2 packets according to the value of the ToS field, and emits them.

In an access network that connects paths to network service providers (NSP-A, B), QoS control is done according to the assigned labels. By assigning labels classified by QoS to packets from the user-side device, flexible QoS control becomes possible in an access network.

Figure 22 shows a mode of implementation in which a layer 2 handler of this invention is provided within a subscriber line concentrator device (optical line terminator, OLT). It has layer 2 handler 22-11 and ATM switch 22-12 within subscriber line concentrator device (OLT) 22-10, and between the user-side device and layer 2 handler 22-11 a PVC (permanent virtual connection) path is extended via ATM switch 22-12.

Also, between layer 2 handler 22-11 and network service provider-side device (NSP-X) and network service provider-side device (NSP-Y) a PVC (permanent virtual connection) path is extended via ATM switch 22-12. An example of the composition of layer 2 handler 22-11 is described as follows.

Figure 23 is an explanatory diagram of an example of the composition of the layer 2 handler of the present invention. In the diagram, (a) shows an example of the composition, (b) shows the pass-through route of a layer 2 packet during software processing, and (c) shows the pass-through route of a layer 2 packet during hardware processing.

Package interface unit 23-11 receives cells from the ATM switch and assembles PPP or other layer 2 packets. Also, layer 2 packets are broken up into ATM cells and passed to the ATM switch.

Layer 2 packet switching unit 23-12 is hardware that performs switching and labeling of PPP and other layer 2 packets; among the layer 2 packets, for packets that require negotiation, processing is passed to layer 2 packet software processing unit 23-13 as shown in (b) of the diagram, and for packets with a link whose connection destination is specified, switching and labeling is done and the packets are emitted to the ATM switch via package interface unit 23-11 as shown in (c) of the diagram.

Layer 2 packet software processing unit 23-13 receives packets that require negotiation and performs negotiation. In this process, the desired connection

destination is specified from the user side, and control of layer 2 packet switching unit 23-12 is carried out.

Figure 24 is an explanatory diagram of the operations of the layer 2 handler of this invention. User A initiates a PPP layer 2 protocol transmission sequence. First, in order to set the PPP connection, an LCP_ConfReq packet is emitted in PPP-over-ATM format on the PVC to the layer 2 handler (24-1).

This packet is received by the layer 2 handler (L2H), and at the layer 2 handler, the PPP packet is taken out by the ATM interface, it goes through the layer 2 switch engine, and it is received by the layer 2 controller. At the layer 2 controller, software processing of this packet is initiated, and an LCP_ConfAck packet is sent back to the user side (24-2).

Also, as an authentication sequence, the layer 2 handing device emits a CHAP_Challenge packet (24-3). In response to this, user A emits his user ID and password (24-4). At this time user A emits his own user ID in the format "aaa@nsp".

This is a format in which one specifies the user ID "aaa" followed by @ and the connection destination network service provider (NSP) name "nsp". By the layer 2 controller receiving a user ID of this format, the layer 2 controller specifies the network service provider (NSP) name "nsp" to be connected with this user.

Using the PVC (permanent virtual connection) path to the network service provider (NSP) name "nsp" to be connected, the layer 2 handler emits to network service provider "nsp" an LCP_ConfReq packet for connection setting in labeled PPP-over-ATM format.

At this time, the layer 2 controller obtains from the label management table a label number, here [2], that is not being used in the PVC (permanent virtual connection) path to network service provider (NSP) "nsp". Then to this label number it emits as the label of [2-0], including marking [0] meaning that it is an emission from the label management side (24-5).

At the device of network service provider "nsp", the LCP_ConfReq of the PPP packet of label [2-0] is received, label [2-1] of the transmission packet that corresponds to received label [2-0] is added, and the LCP_ConfAck of the PPP packet is returned (24-6). Here, for label [2-1], the label number is 2, and marking [1], which means that it is an emission from the label number non-management side, is added.

When the PPP package to which label [2-1] is assigned is received at the layer 2 handler, said packet is recognized as the packet that is paired with [2-0], and processing is done.

In this way, multiple PPP packets can be multiplexed on a single PVC (permanent virtual connection) path by assigning labels to PPP packets between the layer 2 handler and the network service provider (NSP). And by adding a marking that distinguishes whether it is from the label number management side or non-management side, label collisions are avoided even if the management of label numbers is done separately by each device.

Next, the layer 2 handler emits user A's ID and password to network service provider (NSP) "nsp" (24-7). And the layer 2 controller of the layer 2 handler sets the following hardware operation with respect to the layer 2 switch engine unit.

For the PPP packet that arrives from user A's PVC (permanent virtual connection) path it transfers it as a PPP packet to which the label of [2-0] is assigned to the PVC (permanent virtual connection) path to network service provider (NSP) "nsp" (24-9, 24-11).

For the PPP packet to which the label of [2-1] is assigned that arrives from the PVC (permanent virtual connection) path of network service provider "nsp", it removes said label and transfers it to the PVC (permanent virtual connection) path of user A (24-8, 24-10, 24-12).

By this setting, in the subsequent PPP packet communication between user A and network service provider "nsp", transfer is done by hardware via the layer 2 handler.

Using this communication protocol makes it possible to realize the network service provider selection function although it is a PVC (permanent virtual connection) path, and makes it possible to have efficient operation of the network by the traffic line collection effect.

Figure 25 shows an example of the format of a labeled layer 2 packet of this invention. In the diagram, (a) shows the usual PPP-over-ATM packet format, and (b) shows the labeled PPP-over-ATM packet format. The assigned label is stored in the region of (b) indicated by "Label".

As explained above, the present invention makes it possible to select and connect one of specified connection destinations, even if the user-side device is connected by a permanent virtual connection path, by specifying the path of one of the connection request destinations from layer 2 link information emitted from the user-side device connected by a permanent virtual path when a layer 2 link connection request is made, and connecting the permanent virtual connection path of the user-side device to the path of one of the connection request destinations.

Normally with layer 2 packets, only one link can be set on one physical layer circuit, but by converting layer 2 packets to labeled layer 2 packets, it becomes possible to set multiple layer 2 links on one physical layer circuit, and to have efficient operation of the network by the traffic multiplexing effect.

By associating assigned labels with specified connection destinations, switching can be done that is logically separated by the assigned labels, without referring to the IP address in the layer 3 IP header, etc., even if user devices of multiple companies having the same private address are accommodated in layer 2.

The high-speed switching by hardware can be done by doing the switching by the assigned labels of layer 2 packets, without referring to the IP address in the layer 3 IP header, etc.

With the switching by the IP address in the layer 3 IP header, etc., it is impossible to specify the intermediate route nodes, etc., but with switching by layer 2 labels, it becomes possible to specify physical circuit intermediate route nodes, it becomes possible to disperse the load by establishing bypass routes in the event of congestion or fault and doing switching to multiple physical circuit routes, and it is possible to carry out flexible QoS control by associating assigned labels and quality-of-service (QoS) classes.

By associating specified connection destination names and ATM addresses, it becomes possible to selectively connect to network service provider (NSP) or other specified connection destinations that are connected by permanent virtual connection paths, even if the user-side device is unaware of the ATM addresses of the specified connection destinations.

What is Claimed is:

a path specification means that specifies one path of a connection request destination from layer 2 link information that is emitted from the user-side device at the time of a layer 2 link connection request; and

2. The layer 2 link handler as described in claim 1, wherein said path connection means includes a distribution means that, by switching on a layer 2 packet level, distributes and transfers packets that arrive from the permanent virtual connection path connected with the user-side device to one path of the connection request destination.

4. The layer 2 link handler as described in claim 1, wherein said path connection means includes a labeling means that, based on layer 2 link information emitted from the user-side device at the time of a layer 2 link connection request, assigns a label of each layer 2 link of said connection request to a layer 2 packet from the user-side device, said path connection means further including a transfer means that transfers, by label multiplex layer 2 links, a layer 2 packet labeled by said labeling means to the path to said specified connection destination.

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6. The layer 2 link handler as described in claim 4, wherein said labeling means includes a selecting means that, when a label is newly assigned to a layer 2 link, selects an arbitrary available label number and emits a labeled layer 2 packet, and said path connection means handles the link of the labeled layer 2 packet that is assigned the same label number and is sent back from the side of the device that received said labeled layer 2 packet, as a link of the pair of said layer 2 link newly assigned a label.

8. The layer 2 link handler as described in claim 4, wherein said labeling means, when it newly assigns a label to a layer 2 link, determines the label number by doing a negotiation mutually with another device side.

10. The layer 2 link handler as described in claim 5, wherein said path connection means recognizes the labels of layer 2 packets that arrive from the permanent virtual connection path with the user-side device and to which are assigned labels according to the quality-of-service class of each layer 2 link, and transfers layer 2 packets to the path to the specified connection destination that corresponds to the given label.

12. The layer 2 link handler as described in claim 5, wherein said path connection means recognizes the labels of layer 2 packets assigned according to the distribution type of service in the IP packet within layer 2 link packets that arrive from the permanent virtual connection path with the user-side device, and transfers layer 2

13. The layer 2 link handler as described in claim 1, wherein said path connection means includes an extracting means that extracts the request connection destination name from layer 2 link information emitted from the user-side device at the time of a layer 2 link connection request and a conversion table that converts from said connection destination name to a connection address, and path determining means that uses a connection address obtained from said conversion table to cause a path to be connected between the user-side device and the specified connection destination.

15. A layer 2 link path connection method comprising the steps of providing a layer 2 link handler connected by a permanent virtual connection path with the user-side device, extracting by said handler a request connection destination name from layer 2 link information emitted from a user-side device at the time of a layer 2 link connection request, extracting a connection address from said connection destination name by means of a conversion table, and notifying the user-side device connected by a permanent virtual connection path of said connection address, emitting by the user-side device the connection destination address it has been notified of to the network-side device, and based on said connection destination address connected by the network-side device the user-side device and the connection destination by switching of one of permanent virtual connection paths and switched virtual connection paths.

To make an efficient network operation possible in which a user-side device connected by a permanent virtual connection path is selectively connected to one among multiple specified connection destinations, and multiple layer 2 links are multiplexed to one path, a layer 2 link handler is connected to the user-side device by a permanent virtual connection path PVC via the ATM switch the layer 2 link handler has a path specifying units and is connected to multiple specified connection destinations by permanent virtual connection paths or switched virtual connection path via ATM switch that specifies one path of the connection request destinations from layer 2 link information emitted from the user-side device at the time of the layer 2 link connection request, and sets to the path of that specified connection destination a layer 2 link of the permanent virtual connection path PVC of the user-side device. Labels are assigned to layer 2 links, and layer 2 links may be multiplexed..

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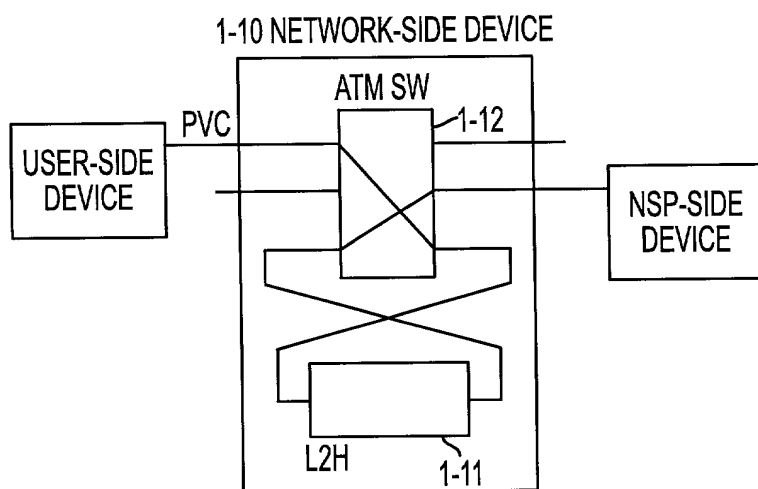


FIG. 1

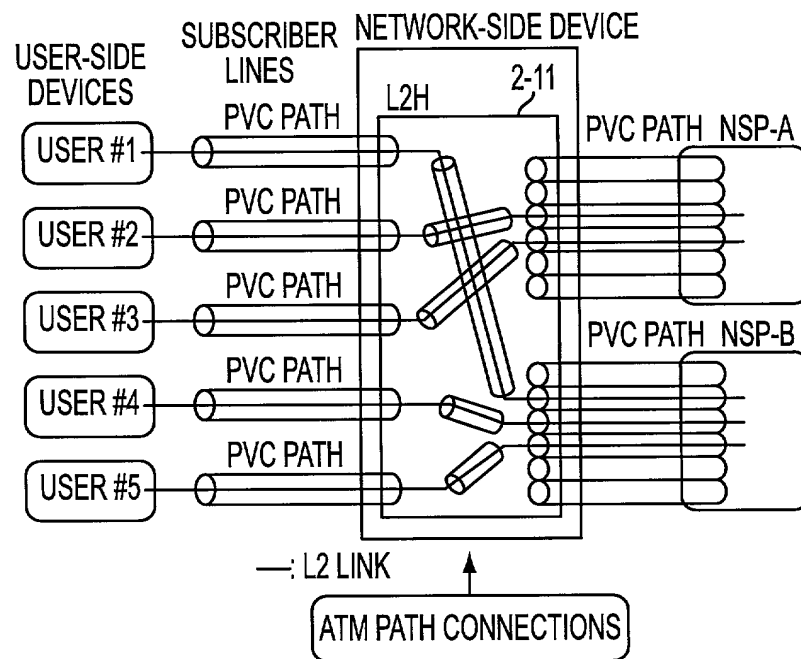
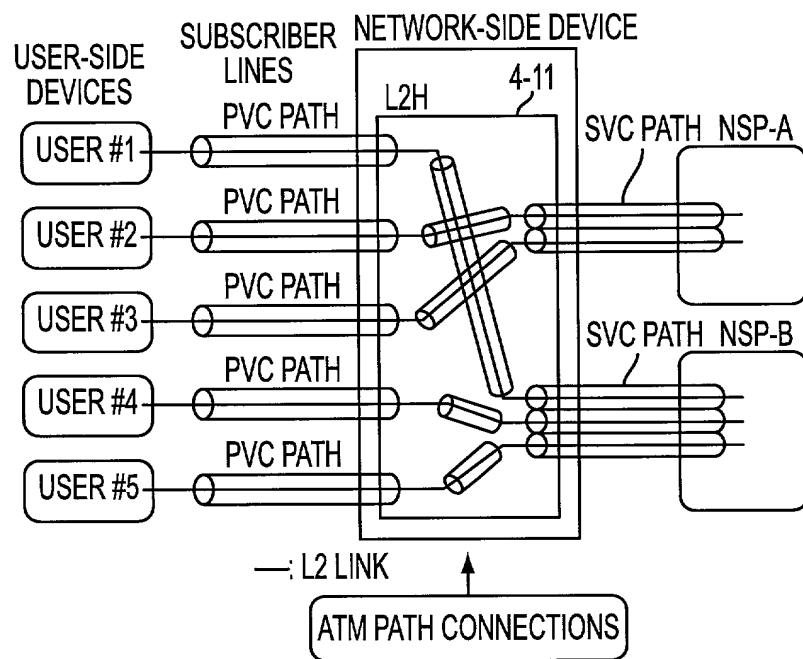


FIG. 2

FIG. 3



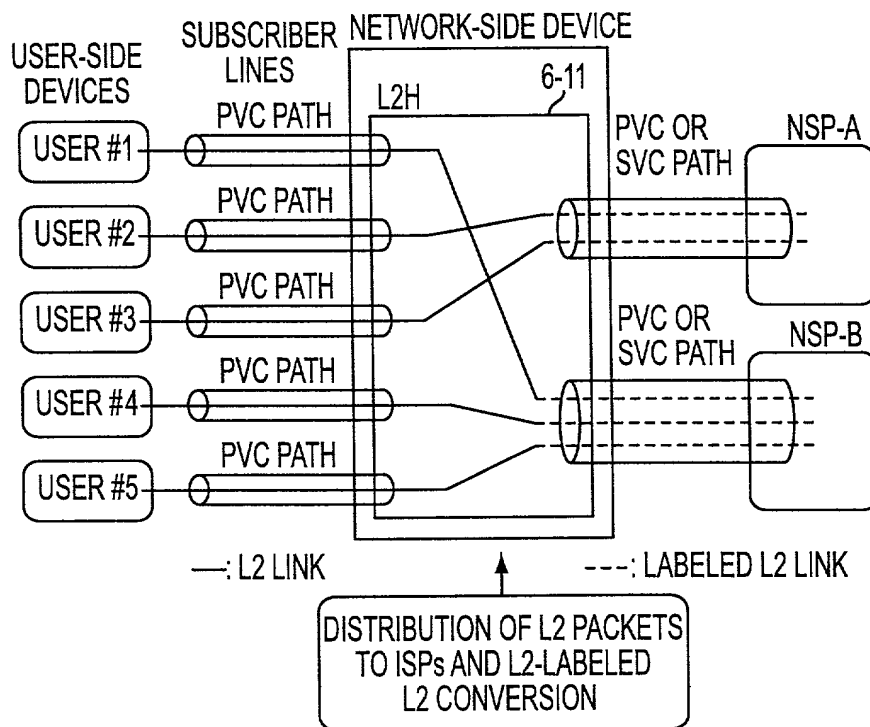


FIG. 6

FIG. 7

The diagram illustrates the sequence of operations for the PPP protocol across three entities: USER, L2H, and NSP. The operations are categorized into three main phases: LCP LINK CONFIGURE, AUTHENTICATION, and IPCP LINK CONFIGURE. The diagram also shows the flow of data between these entities and the processing type (SOFTWARE or HARDWARE).

Entities: USER, L2H, NSP

Phases and Operations:

- LCP LINK CONFIGURE USER-L2H:**
 - USER sends LCP CONF REQ to L2H.
 - L2H sends LCP CONF ACK to USER.
- AUTHENTICATION:**
 - USER sends CHAP CHALLENGE to L2H.
 - L2H sends CHAP ID (WITH @ISP &PW) to USER.
- LCP LINK CONFIGURE L2H-NSP:**
 - L2H sends LCP CONF REQ to NSP.
 - NSP sends LCP CONF ACK to L2H.
- AUTHENTICATION:**
 - L2H sends CHAP CHALLENGE &ID&PW to NSP.
 - NSP sends CHAP RESPONSE to L2H.
- IPCP LINK CONFIGURE:**
 - L2H sends IPCP CONF REQ to NSP.
 - NSP sends IPCP CONF ACK to L2H.

Processing Type:

- SOFTWARE PROCESSING:** LCP LINK CONFIGURE, AUTHENTICATION (USER-L2H), LCP LINK CONFIGURE (L2H-NSP), AUTHENTICATION (L2H-NSP).
- HARDWARE PROCESSING:** IPCP LINK CONFIGURE.

PPP: A long arrow at the bottom indicates the flow of data between USER and NSP.

FIG. 8

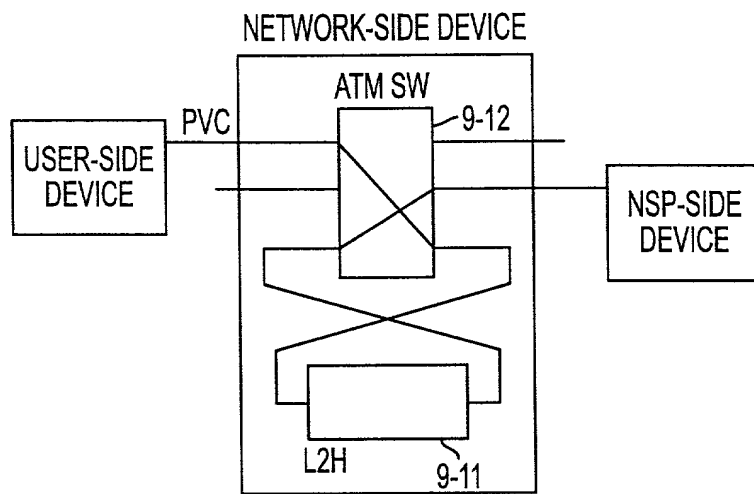


FIG. 9A

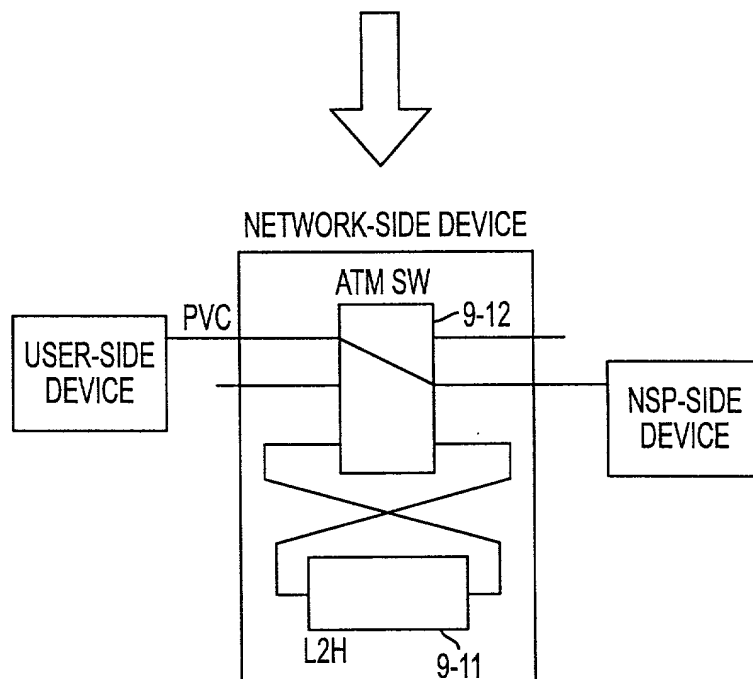


FIG. 9B

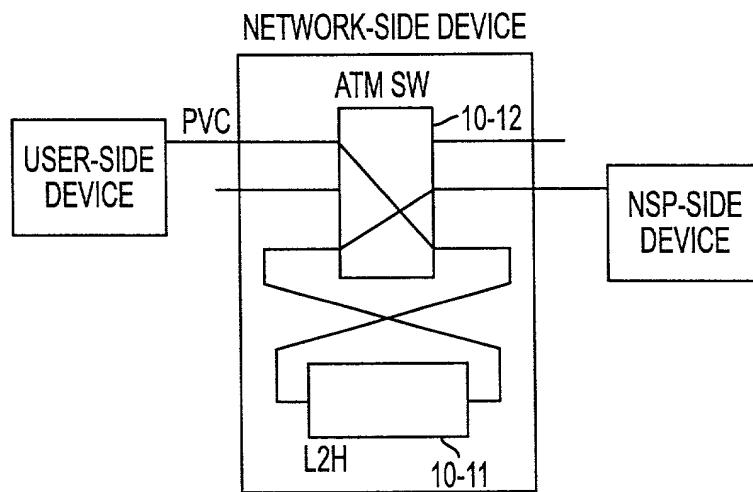


FIG. 10A

NSP NAME	ATM ADDRESS
NSP-A	011014157798702
NSP-B	011014157798467
NSP-C	011014157797356
NSP-D	011014157790533
NSP-E	011014157797824
:	:
NSP-Z	011014157798926

FIG. 10B

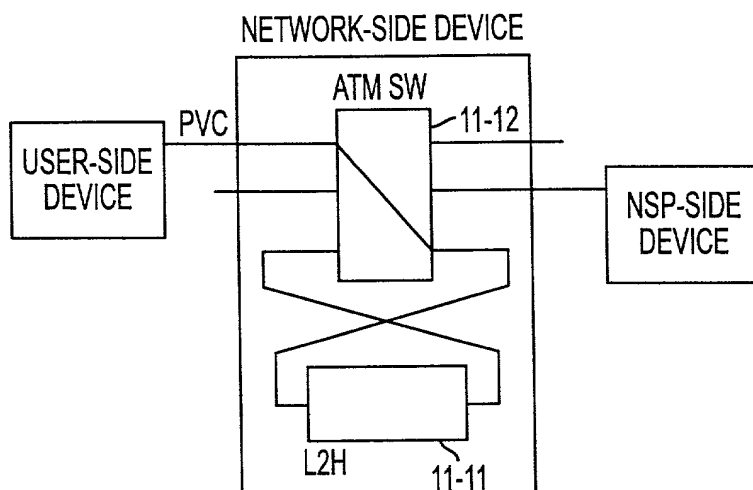


FIG. 11A

EXAMPLE OF TABLE HELD IN L2H

NSP NAME	ATM ADDRESS
NSP-A	011014157798702
NSP-B	011014157798467
NSP-C	011014157797356
NSP-D	011014157790533
NSP-E	011014157797824
:	:
NSP-Z	011014157798926

FIG. 11B

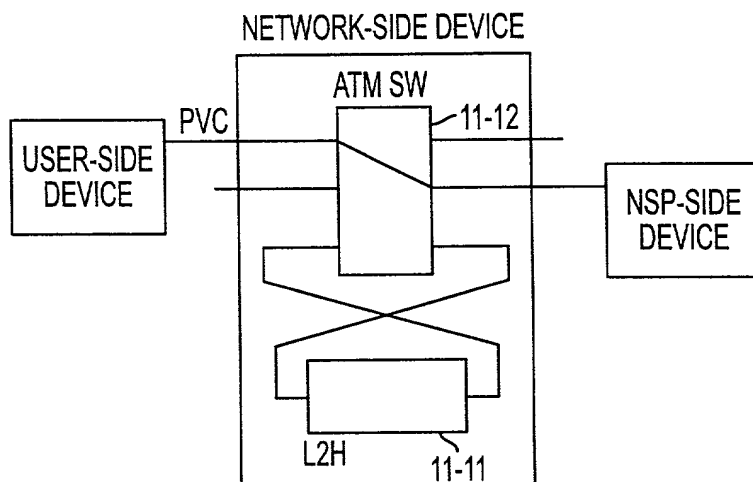
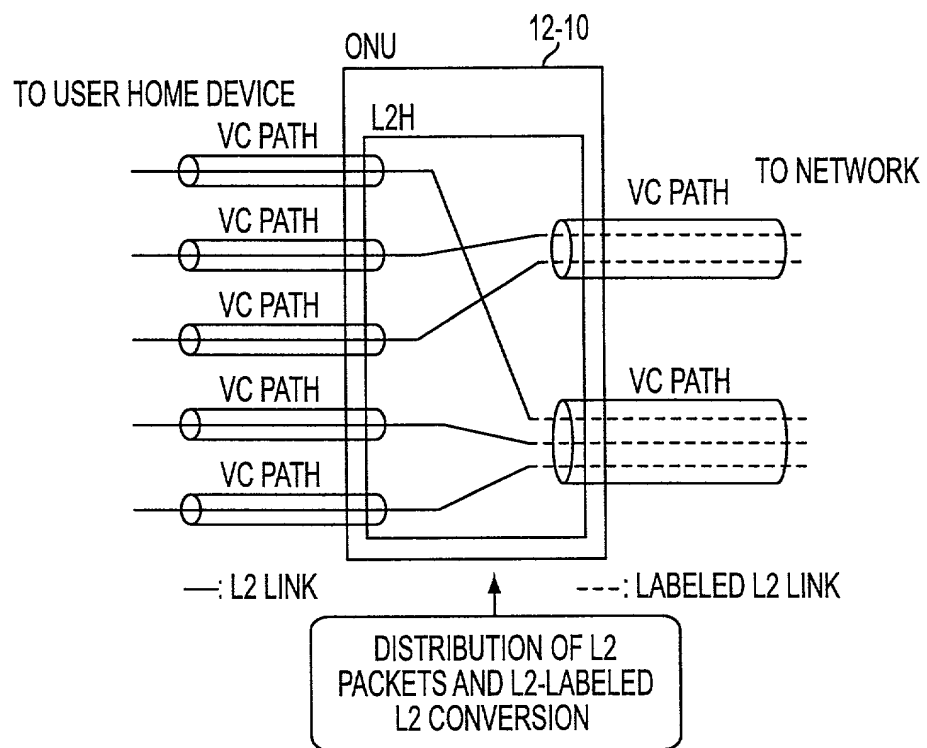


FIG. 11C



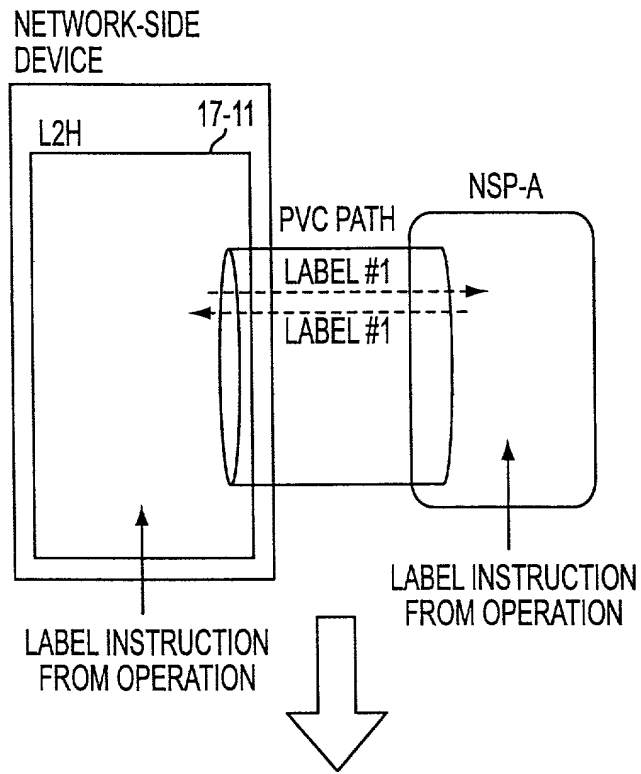


FIG. 17A

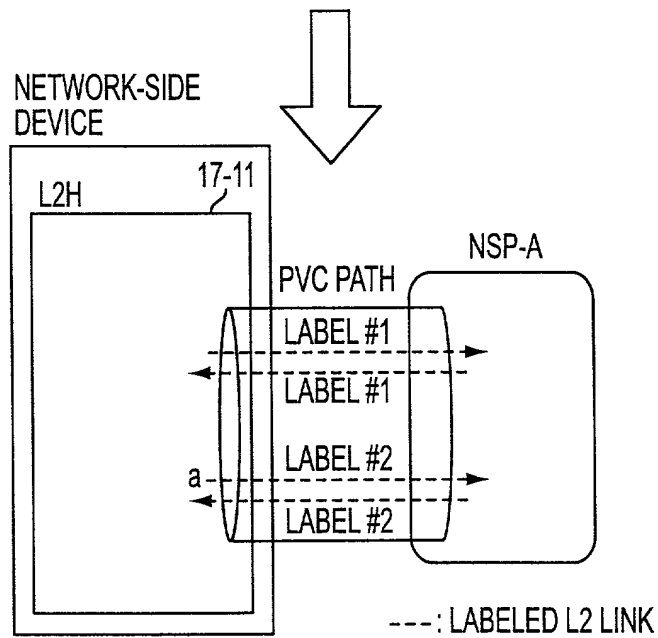


FIG. 17B

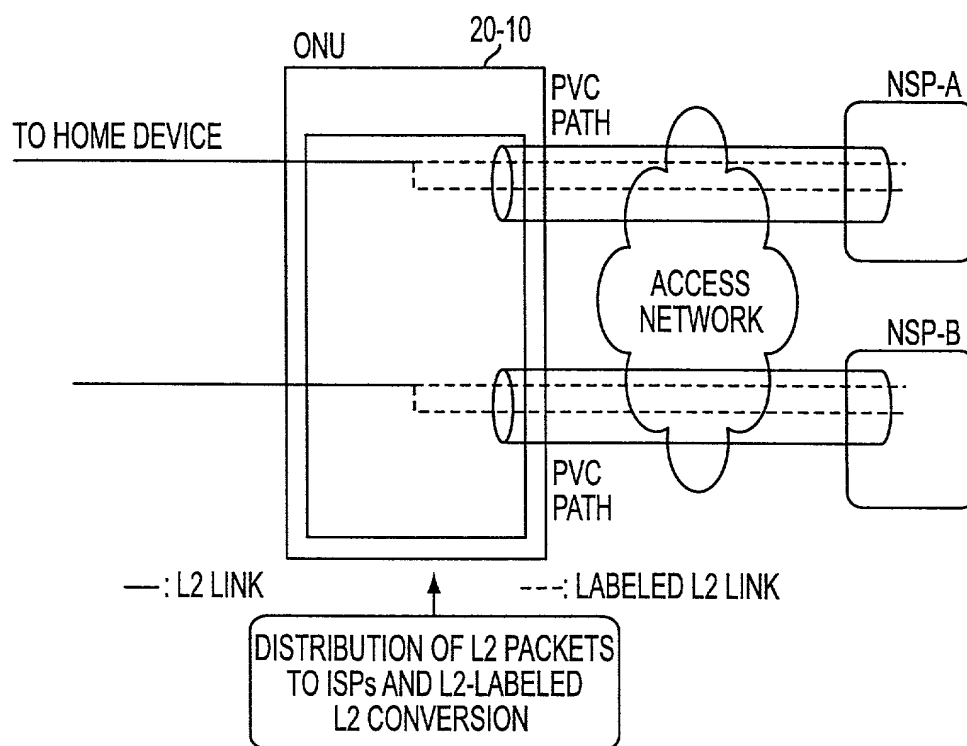


FIG. 21

(24-12)

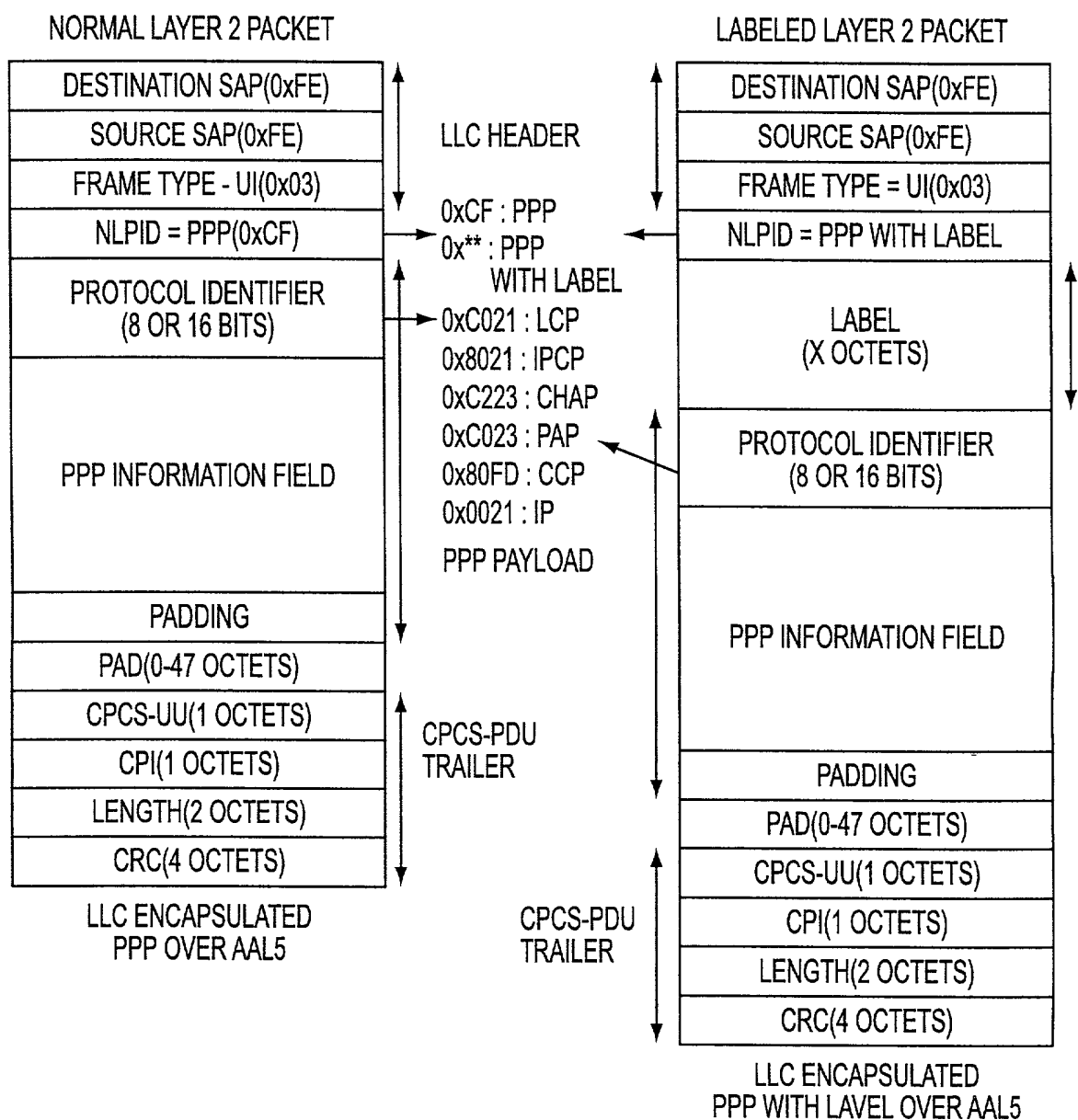


FIG. 25

No.	Cement		Water		Sand		Gravel		Total		Cement	Water	Sand	Gravel	Total	
	kg	l	kg	l	kg	l	kg	l	kg	l						
1	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
2	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
3	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
4	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
5	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
6	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
7	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
8	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
9	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
10	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
11	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
12	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
13	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
14	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
15	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
16	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
17	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
18	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
19	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
20	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
21	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
22	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
23	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
24	100	180	100	180	100	180	100	180	100	180	100	180	100	180	100	180
25	100	180	100	180	100	180	100									

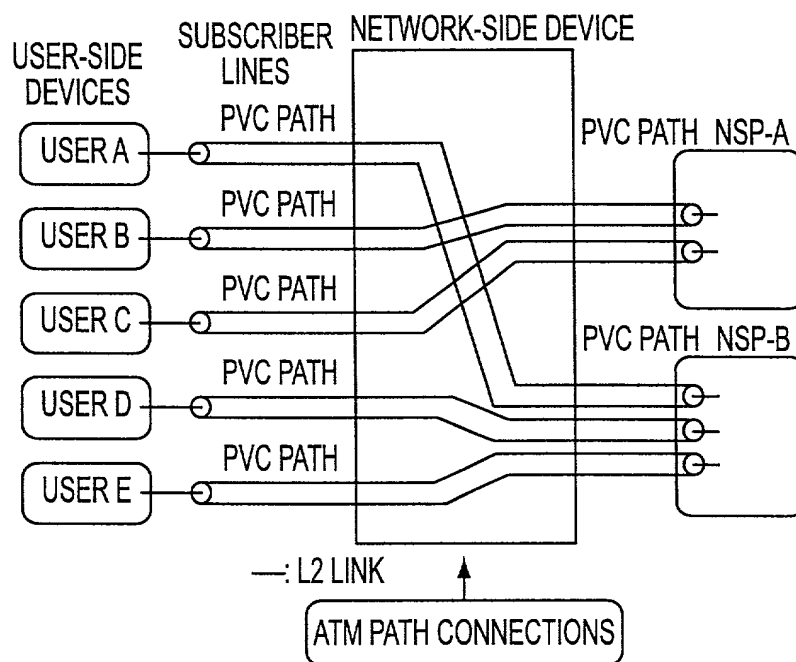


FIG. 26
(PRIOR ART)

FIG. 27
(PRIOR ART)

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Declaration and Power of Attorney For Patent Application**特許出願宣言書及び委任状****Japanese Language Declaration****日本語宣言書**

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

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My residence, post office address and citizenship are as stated next to my name.

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

LAYER 2 LINK HANDLER and PATH CONNECTION
METHOD THEREFORE

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the specification of which is attached hereto unless the following box is checked:

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(該当する場合) _____ に訂正されました。☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

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Prior Foreign Application(s)

外国での先行出願
11-249627

(Number) (番号)	Japan (Country) (国名)
(Number) (番号)	(Country) (国名)

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(Application No.) (出願番号)	(Filing Date) (出願日)
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(Application No.) (出願番号)	(Filing Date) (出願日)
(Application No.) (出願番号)	(Filing Date) (出願日)

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Priority Not Claimed

優先権主張なし

September 3, 1999

(Day/Month/Year Filed)
(出願年月日)

☐

(Day/Month/Year Filed)
(出願年月日)

☐

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)
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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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(Supply similar information and signature for third and subsequent joint inventors.)

